US011989480B2

(12) **United States Patent**
Liao et al.

(10) **Patent No.: US 11,989,480 B2**
(45) **Date of Patent: May 21, 2024**

(54) **SECONDARY DISPLAY LOCATION DETERMINATIONS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/865,069**

(22) Filed: **Jul. 14, 2022**

(65) **Prior Publication Data**

US 2024/0020078 A1 Jan. 18, 2024

(51) **Int. Cl.**
G06F 3/14 (2006.01)
G06F 3/04817 (2022.01)
G06F 3/04842 (2022.01)

(52) **U.S. Cl.**
CPC ***G06F 3/1446*** (2013.01); ***G06F 3/04817*** (2013.01); ***G06F 3/04842*** (2013.01)

(58) **Field of Classification Search**
CPC . G06F 3/1446; G06F 3/04817; G06F 3/04842
See application file for complete search history.

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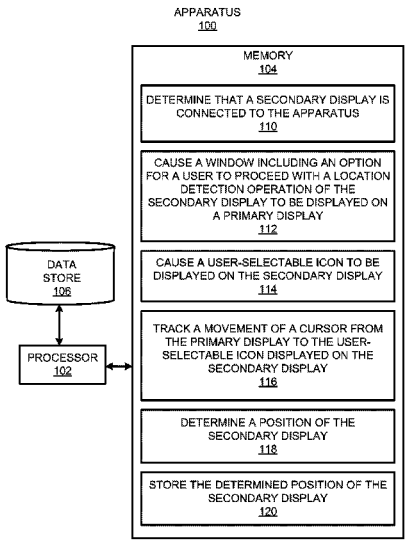
(57) **ABSTRACT**

According to examples, an apparatus may include a processor that may, responsive to a secondary display being detected, cause a window including an option for a user to proceed with a location detection operation of the secondary display to be displayed on a primary display. The processor may also cause an icon to be displayed on the secondary display, track a movement of a cursor from the primary display to the icon displayed on the secondary display, and determine a position of the secondary display with respect to the primary display based on the tracked movement of the cursor. The processor may further store the determined position of the secondary display with respect to the primary display.

19 Claims, 7 Drawing Sheets



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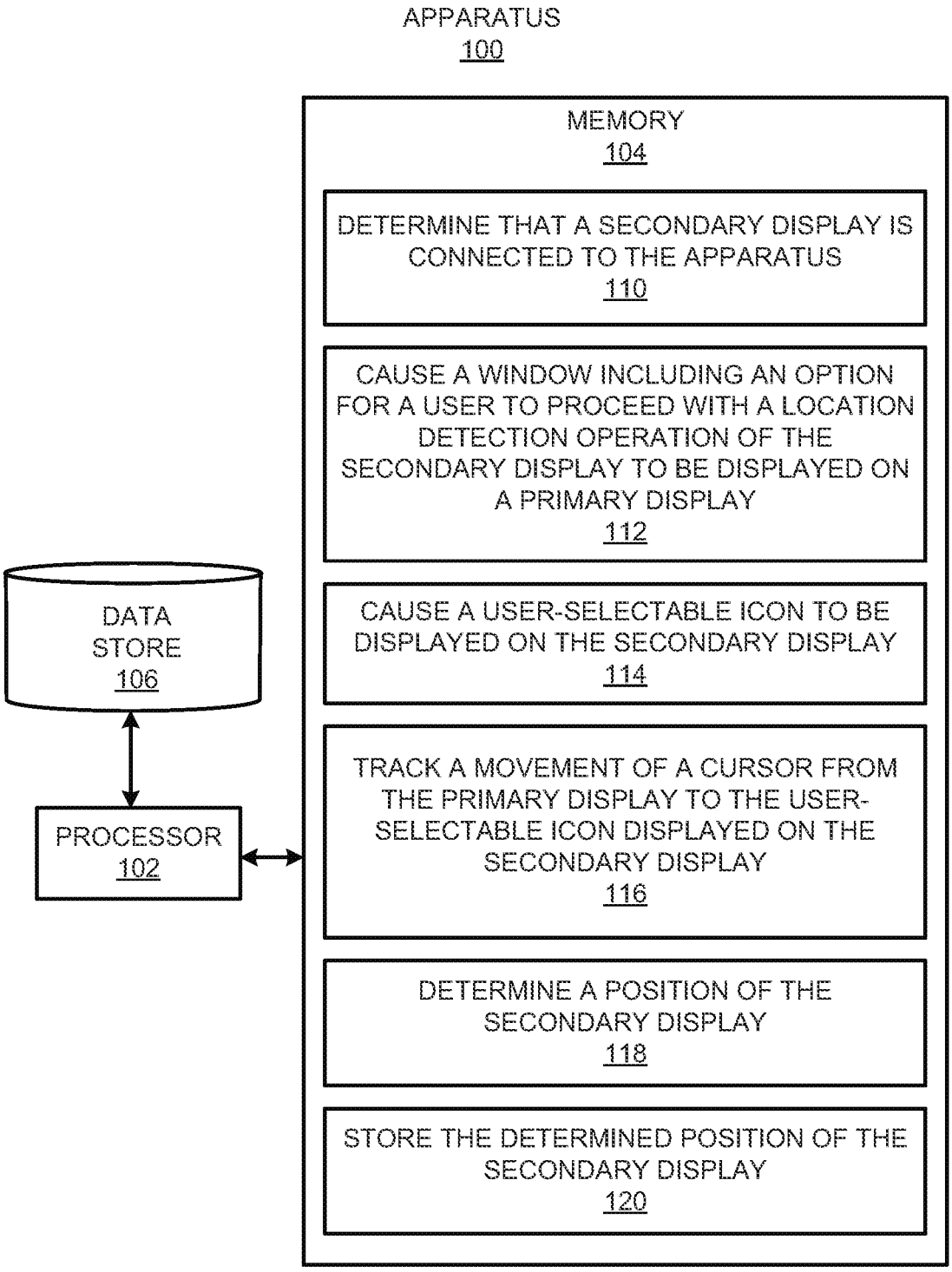
APPARATUS
100
MEMORY
104
DETERMINE THAT A SECONDARY DISPLAY IS CONNECTED TO THE APPARATUS
110
CAUSE A WINDOW INCLUDING AN OPTION FOR A USER TO PROCEED WITH A LOCATION DETECTION OPERATION OF THE SECONDARY DISPLAY TO BE DISPLAYED ON A PRIMARY DISPLAY
112
CAUSE A USER-SELECTABLE ICON TO BE DISPLAYED ON THE SECONDARY DISPLAY
114
TRACK A MOVEMENT OF A CURSOR FROM THE PRIMARY DISPLAY TO THE USER-SELECTABLE ICON DISPLAYED ON THE SECONDARY DISPLAY
116
DETERMINE A POSITION OF THE SECONDARY DISPLAY
118
STORE THE DETERMINED POSITION OF THE SECONDARY DISPLAY
120
DATA STORE
106
PROCESSOR
102

FIG. 1

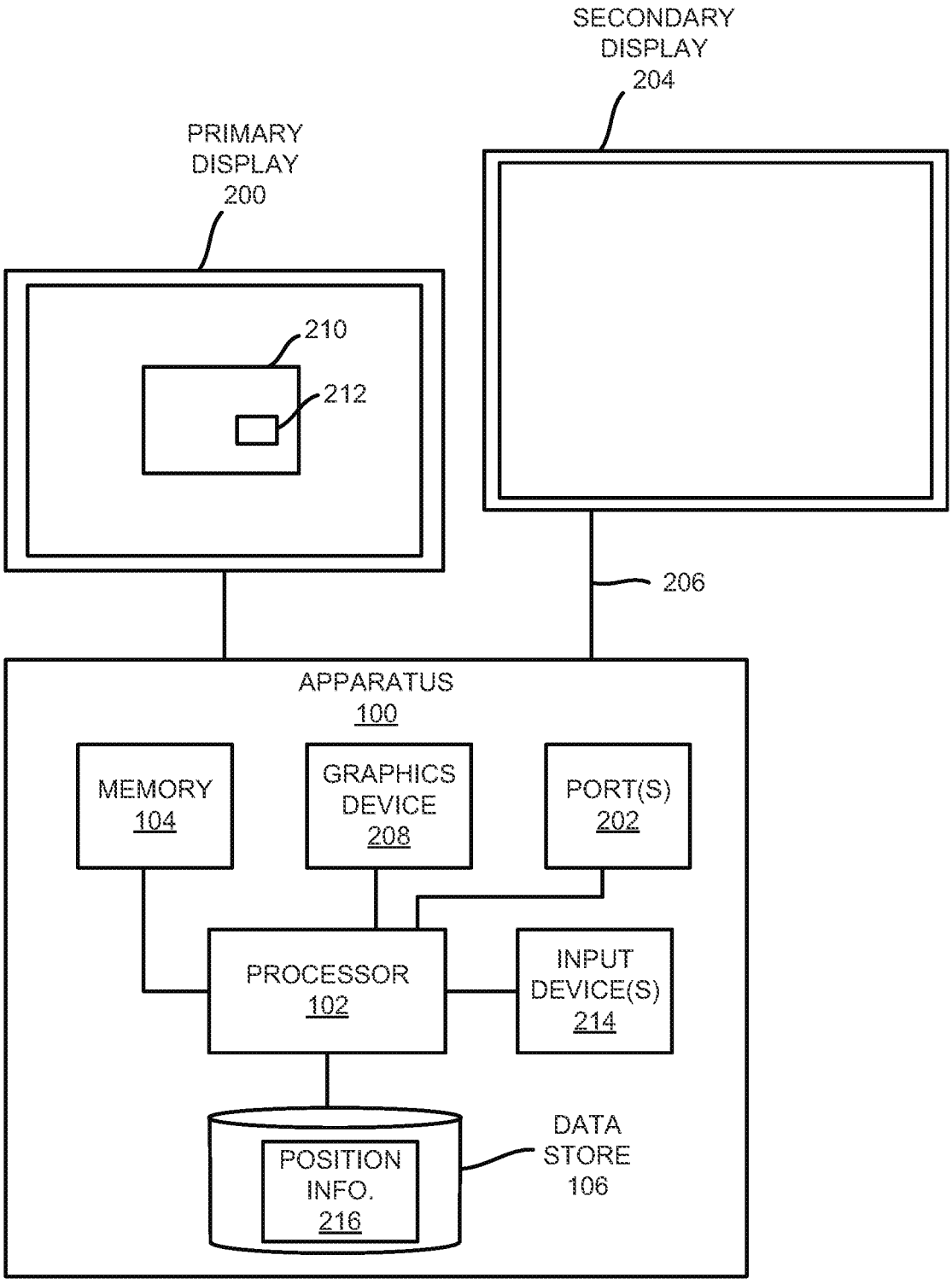
SECONDARY DISPLAY 204
PRIMARY DISPLAY 200
210
212
206
APPARATUS 100
MEMORY 104
GRAPHICS DEVICE 208
PORT(S) 202
PROCESSOR 102
INPUT DEVICE(S) 214
POSITION INFO. 216
DATA STORE 106

FIG. 2

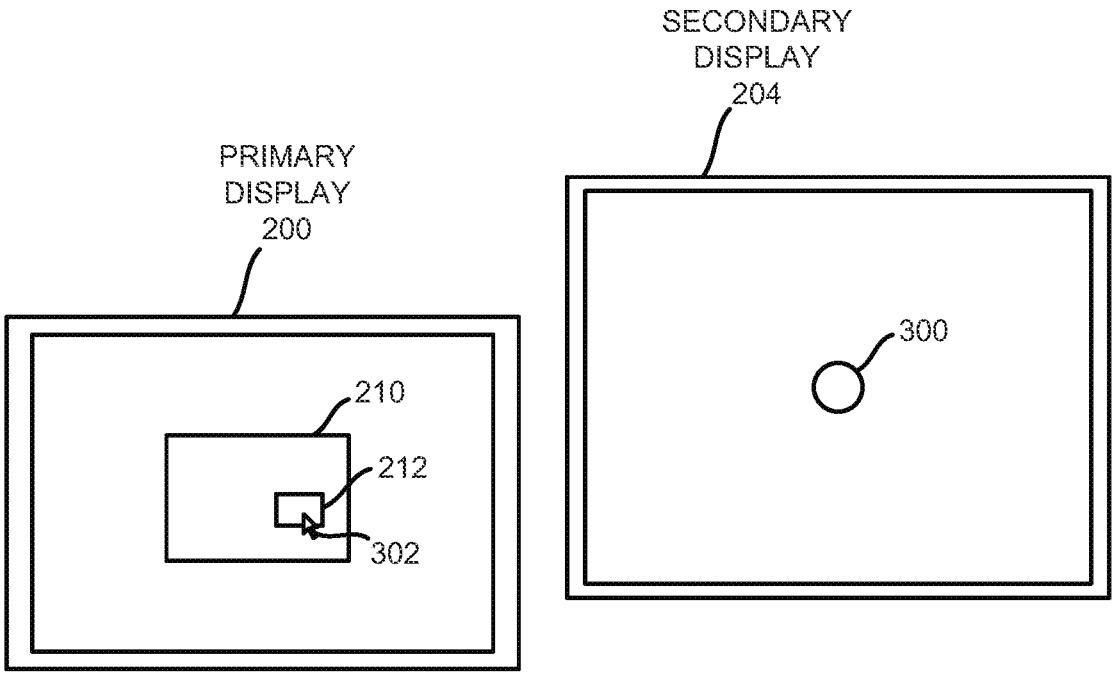
SECONDARY
DISPLAY
204
PRIMARY
DISPLAY
200
300
210
212
302

FIG. 3A

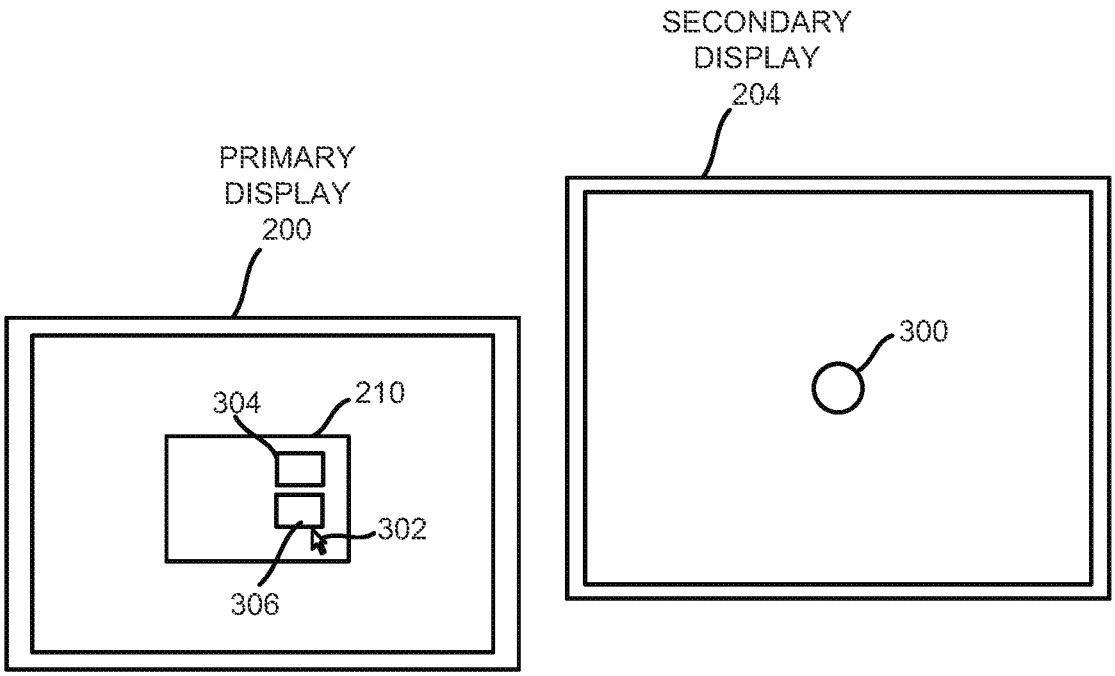
SECONDARY
DISPLAY
204
PRIMARY
DISPLAY
200
300
304
210
302
306

FIG. 3B

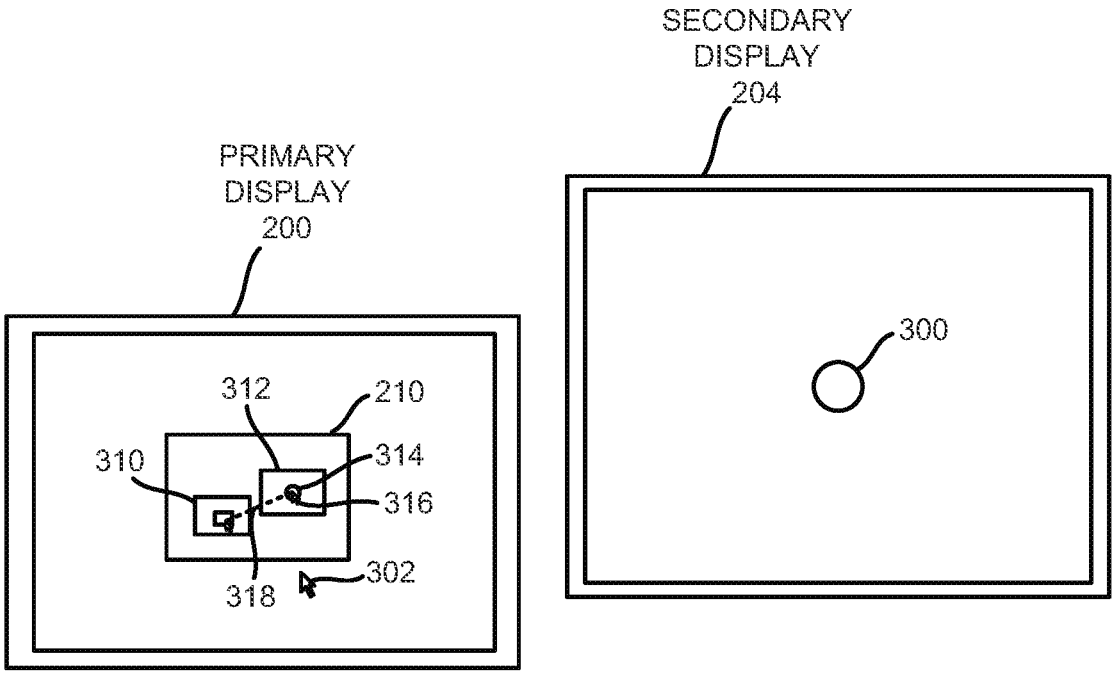
SECONDARY
DISPLAY
204
PRIMARY
DISPLAY
200
300
312
210
310
314
316
318
302

FIG. 3C

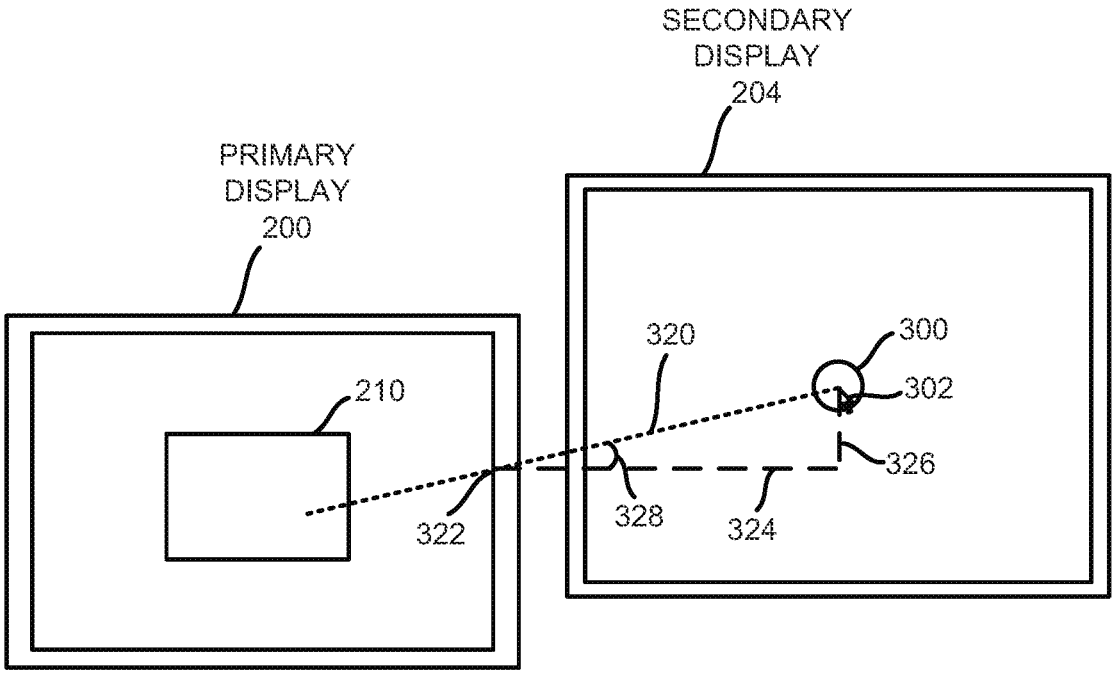
SECONDARY
DISPLAY
204
PRIMARY
DISPLAY
200
320
300
302
210
326
322
328
324

FIG. 3D

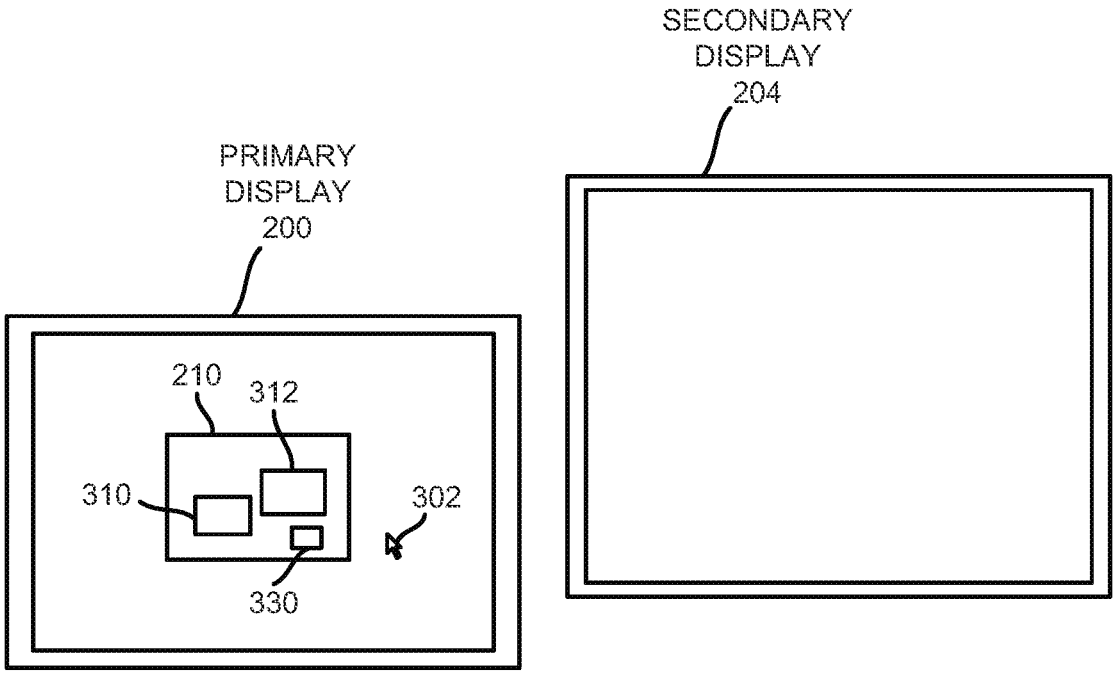
SECONDARY
DISPLAY
204
PRIMARY
DISPLAY
200
210
312
310
302
330

FIG. 3E

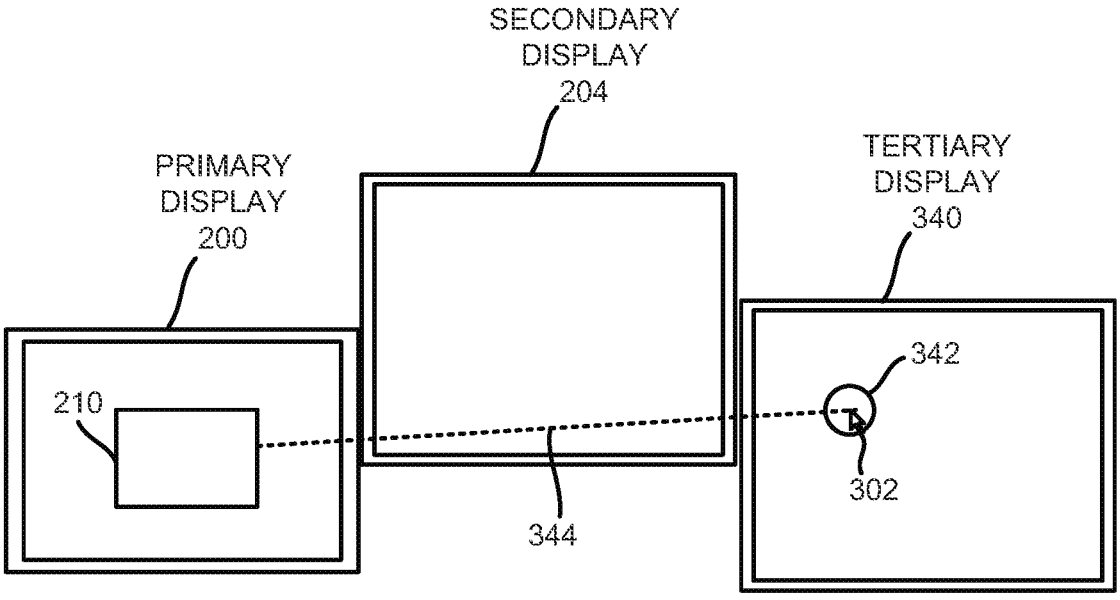
SECONDARY
DISPLAY
204
PRIMARY
DISPLAY
200
TERTIARY
DISPLAY
340
342
210
302
344

FIG. 3F

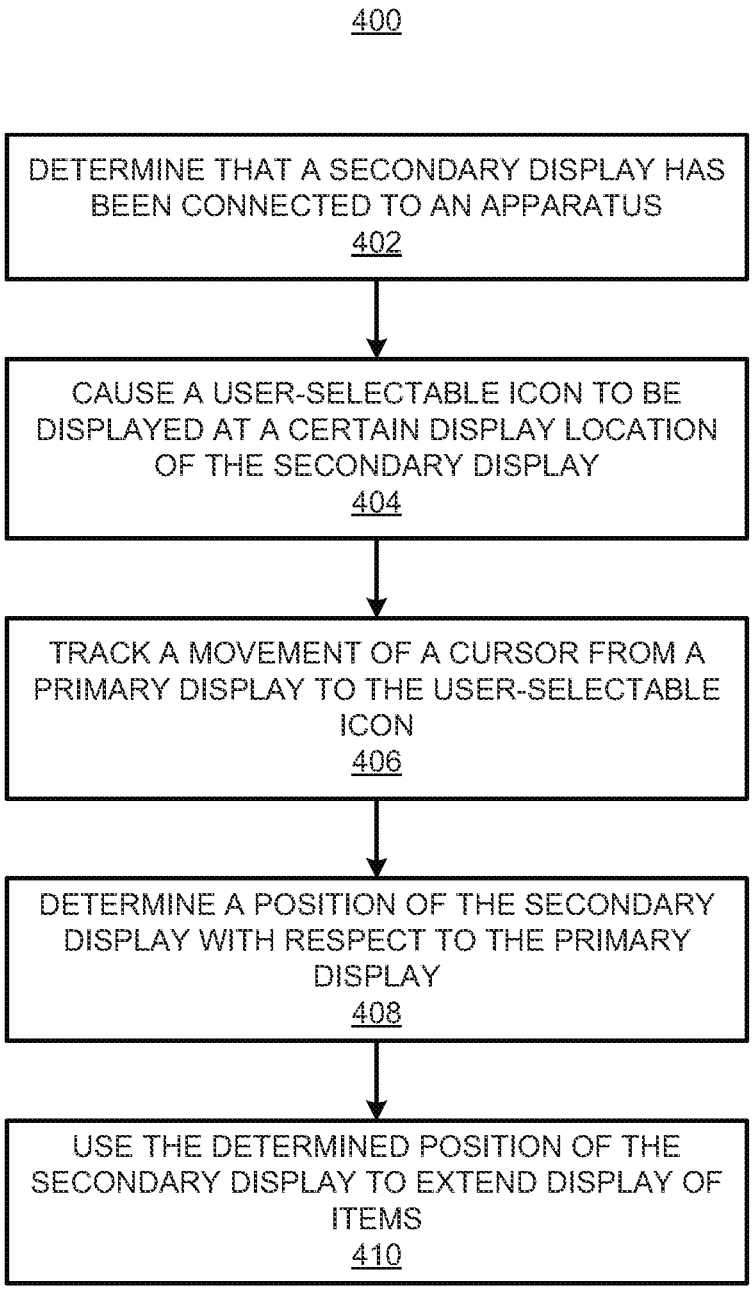
400
DETERMINE THAT A SECONDARY DISPLAY HAS BEEN CONNECTED TO AN APPARATUS
402
CAUSE A USER-SELECTABLE ICON TO BE DISPLAYED AT A CERTAIN DISPLAY LOCATION OF THE SECONDARY DISPLAY
404
TRACK A MOVEMENT OF A CURSOR FROM A PRIMARY DISPLAY TO THE USER-SELECTABLE ICON
406
DETERMINE A POSITION OF THE SECONDARY DISPLAY WITH RESPECT TO THE PRIMARY DISPLAY
408
USE THE DETERMINED POSITION OF THE SECONDARY DISPLAY TO EXTEND DISPLAY OF ITEMS
410

FIG. 4

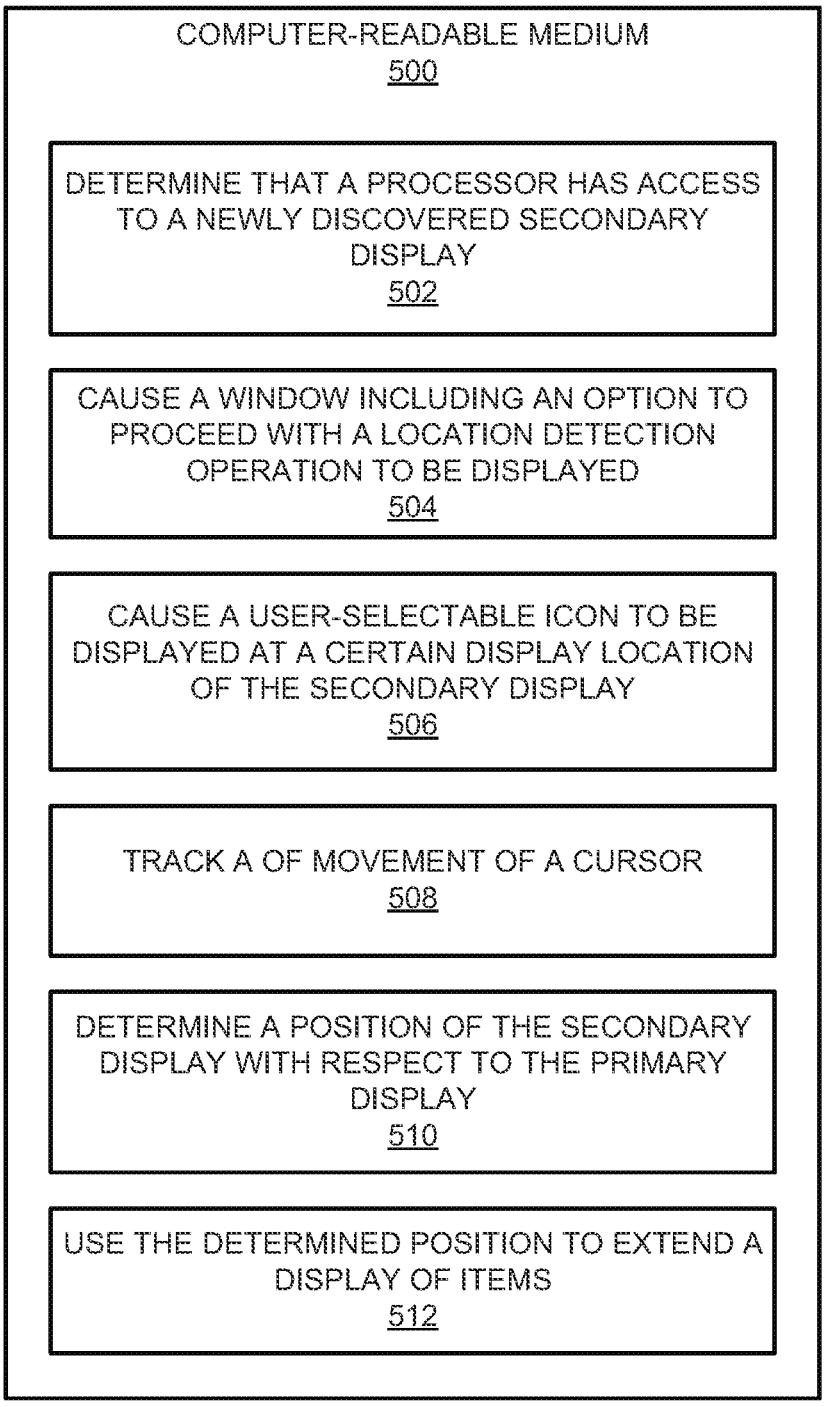
COMPUTER-READABLE MEDIUM
500
DETERMINE THAT A PROCESSOR HAS ACCESS TO A NEWLY DISCOVERED SECONDARY DISPLAY
502
CAUSE A WINDOW INCLUDING AN OPTION TO PROCEED WITH A LOCATION DETECTION OPERATION TO BE DISPLAYED
504
CAUSE A USER-SELECTABLE ICON TO BE DISPLAYED AT A CERTAIN DISPLAY LOCATION OF THE SECONDARY DISPLAY
506
TRACK A OF MOVEMENT OF A CURSOR
508
DETERMINE A POSITION OF THE SECONDARY DISPLAY WITH RESPECT TO THE PRIMARY DISPLAY
510
USE THE DETERMINED POSITION TO EXTEND A DISPLAY OF ITEMS
512

FIG. 5

SECONDARY DISPLAY LOCATION DETERMINATIONS

BACKGROUND

Many users of computing devices, such as desktop and laptop computers, often connect multiple displays to the computing devices. The users may be able to view multiple windows and documents concurrently on the multiple displays. As a result, users may experience greater productivity through use of the multiple displays. Users may often perform manual configuration operations in which the users provide the computing devices with the locations of any secondary displays that are connected to the computing devices.

BRIEF DESCRIPTION OF DRAWINGS

Features of the present disclosure are illustrated by way of example and not limited in the following figure(s), in which like numerals indicate like elements, in which:

FIGS. **1** and **2**, respectively, show block diagrams of an apparatus that includes a processor that may implement a secondary display location detection operation, in accordance with an embodiment of the present disclosure;

FIGS. **3**A-**3**E, respectively, depict diagrams of a primary display and a secondary display during various stages of the secondary display location detection operation, in accordance with an embodiment of the present disclosure;

FIG. **3**F depicts a diagram of a primary display, a secondary display, and a tertiary display, in accordance with an embodiment of the present disclosure;

FIG. **4** depicts a flow diagram of a method for determining a position of a secondary display with respect to a primary display and for using the determined position to extend a display of images between the primary display and the secondary display, in accordance with an embodiment of the present disclosure; and

FIG. **5** shows a block diagram of a computer-readable medium that may have stored thereon computer-readable instructions for determining a position of a secondary display with respect to primary display based on a tracked movement of a cursor from the primary display to an icon displayed at a certain display location of the secondary display, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

For simplicity and illustrative purposes, the principles of the present disclosure are described by referring mainly to embodiments and examples thereof. In the following description, numerous specific details are set forth in order to provide an understanding of the embodiments and examples. It will be apparent, however, to one of ordinary skill in the art, that the embodiments and examples may be practiced without limitation to these specific details. In some instances, well known methods and/or structures have not been described in detail so as not to unnecessarily obscure the description of the embodiments and examples. Furthermore, the embodiments and examples may be used together in various combinations.

Throughout the present disclosure, the terms "a" and "an" are intended to denote at least one of a particular element. As used herein, the term "includes" means includes but not limited to, the term "including" means including but not limited to. The term "based on" means based at least in part on. In the addition, the use of the terms "primary," "secondary," "tertiary," "first," "second," "third," etc., are not intended to denote a specific order or importance of elements, but instead are intended to distinguish the elements with respect to each other.

Users of computing devices may execute a configuration process when new displays are connected to the computing devices. The configuration process may include the display of a window that includes a representation of a display that is currently connected to a computing device and a representation of a newly detected display. A user may move the representation of the newly detected display with respect to the representation of the currently connected display. Particularly, the user may, using a mouse, select the representation of the newly detected display, for instance, by "clicking" on that representation. The user may then move that representation to a location in the window that the user believes approximately corresponds to the location of the newly detected display with respect to the currently connected display. The computing device may use the positions of the representations in extending the display of images between the currently connected display and the newly detected display.

In many instances, as the users are guessing at the position of the secondary display with respect to the primary display, the users may not accurately position representations of newly detected displays with respect to representations of currently connected displays. The users may not determine that the positioning of the representations are inaccurate until the users begin using the newly detected displays. As a result, the users may be required to initiate the configuration process again to correct the positions of the representations of the currently connected displays. In many instances, users may be unaware that they have the ability to reposition the displays and may simply use the displays in their existing positions, which may result in a less than ideal user experience with the displays. Technical issues associated with the configuration of newly added displays may thus be that they may be prone to errors and require multiple attempts. This may increase the amount of time required, processing resources used, and energy used in setting up additional displays.

Disclosed herein are apparatuses, methods, and computer-readable mediums that may enable the locations of external displays with respect to previously connected primary displays to be determined in accurate and efficient manners. Particularly, a processor may cause an icon to be displayed at a certain display location on a newly discovered display, e.g., a secondary display, a tertiary display, and may track a movement of a cursor from the primary display to the icon. That is, the processor may track a movement of a cursor by a user from a position on the primary display to the icon displayed on the newly discovered display and the processor may determine when the cursor is over the icon and/or when a user has clicked on or otherwise selected the icon. The tracked movement may be a horizontal distance, a vertical distance, and/or an angle of movement of the cursor. The processor may use the tracked movement of the cursor to determine the position of the certain display location of the secondary display with respect to the primary display. In addition, the processor may use the determined certain display location to determine the location of the secondary display with respect to the primary display.

The features of the present disclosure may be extended to other secondary displays, e.g., a tertiary display, a quaternary display. In these instances, the processor may cause an icon to be displayed at a certain display location on at least

one of the secondary displays. In addition, the processor may track a movement of a cursor from the primary display and/or the secondary display to the icon(s) displayed on the other secondary display(s). The processor may also determine the location(s) of the other secondary display(s) with respect to the primary display and/or the secondary display based on the tracked movement.

Through implementation of features of the present disclosure, a processor of an apparatus may accurately and efficiently determine the location of at least one secondary display with respect to a primary display. The determination of the at least one secondary display location may relatively be more accurate than other location determination techniques because the processor may determine the certain display location(s) of the secondary display through tracking of a mouse movement to the icon(s) displayed at the certain display location(s). Technical improvements afforded through implementation of the features of the present disclosure may include accurate and efficient set up of at least one secondary display. That is, the features of the present disclosure may enable the efficient determinations of secondary display locations because the features enable the secondary display locations to be determined accurately at an initial time that a location operation is performed. This may reduce or optimize the amount of time, processing resources, and energy consumed in determining the locations of the secondary displays with respect to primary displays. The features of the present disclosure may also improve human-computer interactions in setting up secondary displays.

Reference is first made to FIGS. **1** and **2**, which respectively show block diagrams of an apparatus **100** that may include a processor **102** that may implement a secondary display location detection operation, in accordance with an embodiment of the present disclosure. It should be understood that the apparatus **100** depicted in FIGS. **1** and **2** may include additional features and that some of the features described herein may be removed and/or modified without departing from the scope of the apparatus **100**.

As shown in FIGS. **1** and **2**, the apparatus **100** may include a processor **102** that may control operations of the apparatus **100**. It should be understood that references made herein to the apparatus **100** performing various operations should equivalently be construed as meaning that the processor **102** of the apparatus **100** may perform those various operations. The apparatus **100** may also include a memory **104** on which instructions that the processor **102** may access and/or may execute may be stored. In addition, the processor **102** may include a data store **106** on which the processor **102** may store and access various information as discussed herein. The processor **102** may be a semiconductor-based microprocessor, a central processing unit (CPU), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), and/or other hardware device.

Although the apparatus **100** is depicted as having a single processor **102**, it should be understood that the apparatus **100** may include additional processors and/or cores without departing from a scope of the apparatus **100**. In this regard, references to a single processor **102** as well as to a single memory **104** may be understood to additionally or alternatively pertain to multiple processors **102** and/or multiple memories **104**. In addition, or alternatively, the processor **102** and the memory **104** may be integrated into a single component, e.g., an integrated circuit on which both the processor **102** and the memory **104** may be provided.

The memory **104** and the data store **106**, which may also each be termed a computer readable medium, may each be a Random Access memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage device, or the like. The memory **104** and/or the data store **106** may be a non-transitory computer readable storage medium, where the term "non-transitory" does not encompass transitory propagating signals.

Generally speaking, the apparatus **100** may be a computing device such as a laptop computer, a desktop computer, a tablet computer, a smartphone, and/or the like. As shown in FIG. **2**, a primary display **200** (which may also be referenced herein as a first display **200**) may be connected to the apparatus **100**. The primary display **200** may be any suitable type of display, such as a liquid crystal display (LCD) display, a light emitting diode (LED) display, an organic LED display, a plasma display, and/or the like. In examples in which the apparatus **100** is a laptop computer, a tablet computer, or a smartphone, the primary display **200** may form part of the apparatus **100**. For instance, the primary display **200** may be integrated with the apparatus **100** such that the primary display **200** and the apparatus **100** share a common housing or a housing of the primary display **200** is connected to a housing of the apparatus via a fixed or movable connection.

In examples in which the apparatus **100** is a desktop computer or other type of computing device that may not have an integrated display or that may have multiple displays, the primary display **200** may be connected to a port **202** of the apparatus **100** through a cable. Particularly, for instance, the port **202** may be a high-definition multimedia interface (HDMI) port, a DisplayPort, a universal serial bus (USB) port, a VGA port, a DVI port, and/or the like. In addition, the cable connecting the primary display **200** to the apparatus **100** may be a corresponding type of cable.

In some examples in which multiple displays are connected to the apparatus **100**, the primary display **200** may be a display that was previously connected to the apparatus **100**. In other words, the processor **102** may have previously detected the primary display **200** and may have determined a position of the primary display **200** with respect to another display (not shown), e.g., a third or tertiary display. For instance, the primary display **200** may be a display that is integrated with a laptop computer or a tablet computer. In other examples, the primary display **200** may be a display that is connected to a desktop computer, a laptop computer, a tablet computer, etc.

As also shown in FIG. **2**, a secondary display **204** (which may also referenced herein as a second display **204**) may also be connected to the apparatus **100** via a cable **206** and a port **202** in the apparatus **100**. The cable **206** may be connected to a different port **202** in the apparatus **100** than the primary display **200**. In other examples, the secondary display **204** may be connected to the apparatus **100** indirectly, e.g., via a docking station, a hub, a wireless connection, via another apparatus (such as another computing device). By way of particular example, a computing device, or an electronic device, such as a television, may include or be connected to a display and the secondary display **204** may be that display. In this example, the computing device or electronic device may broadcast an ability for another computing device to take over the usage of the display to which the computing device or electronic device is connected. In addition, the processor **102** may take over the usage of that display from the computing device or electronic device.

The secondary display **204** may be any suitable type of display, such as a LCD display, a LED display, an OLED display, a plasma display, and/or the like. The terms "primary display" and "secondary display" are not intended to

denote that one display is used as a main display over the other display. Instead, the "primary display" may be distinguished from the "secondary display" in that the processor **102** may have caused images to be displayed on the primary display **200** prior to the use of the secondary display **204** to display images. Likewise, the processor **102** may have sent images to be displayed on the primary display **200** prior to the secondary display **204** being connected to the apparatus **100**.

In some examples, the processor **102** may receive information about the secondary display **204** from the secondary display **204** through the connection with the secondary display **204**. The information about the secondary display **204** may include the resolution of the secondary display **204**, the physical dimensions of the display size of the secondary display **204**, and/or the like. The processor **102** may use this information to determine a certain display location of the secondary display **204**.

The processor **102** may cause images to be displayed on the primary display **200** and the secondary display **204** through use of a graphics device **208**. The graphics device **208** may be a graphics card, an integrated graphics chip, a graphics processing unit, and/or the like. Generally speaking, the processor **102** may communicate information about images to be displayed on the primary display **200** and the secondary display **204** to the graphics device **208**. The graphics device **208** may determine how to use pixels in the primary display **200** and the secondary display **204** and may send that information to the primary display **200** and the secondary display **204** through respective connections. In addition, images corresponding to the information may be displayed on the primary display **200** and the secondary display **204**.

Various operations performed by the processor **102** to cause certain images to be displayed on the primary display **200** and the secondary display **204** are described with respect to FIGS. **1**, **2**, and **3**A-**3**F. FIGS. **3**A-**3**E, respectively, depict diagrams of the primary display **200** and the secondary display **204** during various stages of the location detection operation of the secondary display **204**, in accordance with an embodiment of the present disclosure. FIG. **3**F depicts a diagram of a primary display **200**, a secondary display **204**, and a tertiary display **340**, in accordance with an embodiment of the present disclosure. It should be understood that the features of the primary display **200** and the secondary display **204** depicted in FIGS. **3**A-**3**F are for purposes of illustration and should thus not be construed as limiting the present disclosure in any respect. Additionally, it should be understood that the positioning of the secondary display **204** with respect to the primary display **200** in FIGS. **2**-**3**F are for purposes of illustration and should thus not be construed as limiting the present disclosure in any respect. For instance, the secondary display **204** may be positioned to the left, above, below, etc., the primary display **200**.

With particular reference to FIGS. **1** and **2**, the memory **104** may have stored thereon machine-readable instructions **110**-**120** that the processor **102** may execute. The processor **102** may execute the instructions **110** to determine that a secondary display **204** is connected to the apparatus **100**. The processor **102** may make this determination when a cable **206** is connected to both the apparatus **100** and the secondary display **204**. For instance, the processor **102** may determine that the secondary display **204** has been connected to the apparatus **100** as part of a "plug and play" operation of the secondary display **204**.

In some examples, the processor **102** may determine whether the secondary display **204** was previously connected to the apparatus **100** or whether the present connection is a first time that the secondary display **204** has been connected to the secondary display **204**. The processor **102** may determine that the secondary display **204** was not previously connected to the apparatus **100**, e.g., is a first run of the connection of the secondary display **204** to the apparatus **100**, based on a determination that the processor **102** does not have information about the secondary display **204** stored in the data store **106**.

Based on a determination that the secondary display **204** is not a previously known display, the processor **102** may execute a first run experience operation for the secondary display **204**. The first run experience operation may be an operation that assists users in setting up the secondary display **204**. For instance, the first run experience operation may include a location detection operation of the secondary display **204** that may enable the processor **102** to determine the location of the secondary display **204** with respect to the location of the primary display **200** in a relatively simple and efficient manner.

The processor **102** may execute the instructions **112** to, responsive to the secondary display **204** being detected, cause a window **210** including an option **212** for a user to proceed with a location detection operation of the secondary display **204** to be displayed on the primary display **200**. In some examples, the processor **102** may cause the window **210** including the option **212** to be displayed on the primary display **200** in response to a determination that the secondary display **204** is connected to the apparatus **100** for a first time. In these examples, the processor **102** may not cause the window **210** to be displayed on the primary display **200** in response to a determination that the secondary display **204** was previously connected to the apparatus **100**.

An example of the window **210** and the option **212** are depicted in FIG. **2**. The window **210** may be a pop-up window that the processor **102** may instruct the graphics device **208** to display on the primary display **200**. In addition, the processor **102** may instruct the graphics device **208** to display the option **212** within the window **210** as, for instance, a button that the user may select. The window **210** may also include an option for discontinuing the location detection operation of the secondary display **204**. Based on a determination that the option for discontinuing the location detection operation of the secondary display **204** has been selected, the processor **102** may cancel the location detection operation. This may cause the secondary display **204** to be used to mirror the images displayed on the primary display **200**.

However, based on a determination that the option **212** for proceeding with the location detection operation of the secondary display **204** has been selected, the processor **102** may execute the instructions **114** to cause an icon **300** to be displayed on the secondary display **204**. An example of the icon **300** is depicted in FIG. **3**A. According to examples, the icon **300** may be positioned at a certain display location of the secondary display **204**. The processor **102** may determine the certain display location of the secondary display **204** from the information about the secondary display **204** received from the secondary display **204**. For instance, the processor **102** may determine the certain display location of the secondary display **204** from the resolution and/or the physical size of the secondary display **204** identified in the information received from the secondary display **204**. The certain display location may be the central display location of the secondary display **204**.

In other examples, the icon **300** may be positioned at a location of the secondary display **204** other than the central

display location of the secondary display **204**. For instance, the processor **102** may determine another location of the secondary display **204** at which the icon **300** may be displayed. As the processor **102** may know the location at which the icon **300** is displayed, the processor **102** may determine the position of the secondary display **204** with respect to the primary display **200** as discussed herein. In some examples, the processor **102** may cause a plurality of icons **300** to be displayed at certain locations on the secondary display **204**. In these examples, the processor **102** may track movements of the cursor **302** to the plurality of icons **300** and may determine the position of the secondary display **204** with respect to the primary display **200** based on the tracked movements.

In some examples, the icon **300**, which may also be termed a button or other type of selectable displayed element, may include text to instruct a user to select the icon **300**. For instance, the icon **300** may include text, such as "Select Here," "Press Here," or the like.

According to examples, and as shown in FIG. **3**B, the processor **102** may cause the window **210** to display options **304**, **306** for the user to select whether the secondary display **204** is to duplicate the primary display **200** or to extend the display of the primary display **200**. Images displayed on the primary display **200** may be duplicated on the secondary display **204** when the duplicate display option **304** is selected. The secondary display **204** may extend the display of the primary display **200**, e.g., different, but contiguous desktop screens may be displayed on the primary display **200** and the secondary display **204**, when the extend display option **306** is selected. In contrast, the secondary display **204** may mirror or copy the desktop screen displayed on the primary display **200**, when the duplicate or mirror option is selected. In addition, the processor **102** may cause the icon **300** to be displayed on the secondary display **204** in response to a detection that the secondary display **204** is to extend the display of the primary display **200**. However, the processor **102** may cancel the location detection operation of the secondary display **204** in response to a detection that the secondary display **204** is to duplicate the display of the primary display **200**. In this instance, the processor **102** may not cause the icon **300** to be displayed on the secondary display **204**.

In instances in which the processor is to continue with the location detection operation of the secondary display **204**, the processor **102** may cause representations **310**, **312** of the primary display **200** and the secondary display **204** to be displayed on the primary display **200**. An example of a window **210** in which the representations **310**, **312** of the primary display **200** and the secondary display **204** are displayed is depicted in FIG. **3**C. FIG. **3**C also depicts a representation **314** of the icon **300** and a representation **316** of a cursor **302**. In some examples, the processor **102** may cause an animation of the cursor **302** moving from the representation **310** of the primary display **200** to the representation **314** of the icon **300** displayed on the representation **312** of the secondary display **204** to instruct the user to move the cursor **302** displayed on the primary display **200** to the icon **300** displayed on the secondary display **204**. The animation is represented by the dotted line **318**, which may be repeated a number of times, e.g., until the user moves the cursor **302** and selects the icon **300**.

The user may move the cursor **302** from a current position on the primary display **200** to the icon **300** displayed on the secondary display **204**. The user may move the cursor **302** through use of an input device **214**, which may be a mouse, a trackpad, a roller, a pen, a microphone (e.g., through voice commands), and/or the like. In addition, the processor **102** may execute the instructions **116** to track a movement of the cursor **302** from the primary display **200** to the icon **300** displayed on the secondary display **204**. For instance, when the user selected to continue with the location detection operation of the secondary display **204**, the cursor **302** may be displayed on the primary display **200**. In addition, the user may move the cursor **302** from the primary display **200** to the icon **300** displayed on the secondary display **204**. As discussed in greater detail below, the processor **102** may track the angle at which the cursor **302** moved from when the cursor **302** moved from the primary display **200** to the secondary display **204** toward the icon **300**.

The processor **102** may execute the instructions **118** to determine a position of the secondary display **204** with respect to the primary display **200** based on the tracked movement of the cursor **302**. That is, for instance, the processor **102** may determine the location of the center of the secondary display **204** with respect to the primary display **200** based on the angle at which the cursor **302** moved from an edge of the primary display **200** to the icon **300** displayed on the secondary display **204**. The processor **102** may determine when the cursor **302** is positioned over the icon **300** and/or when a user selects or clicks on the icon **300**.

As shown in FIG. **3**D, the processor **102** may track the movement of the cursor **302** as the cursor **302** is moved from the primary display **200** to the secondary display **204**. The movement of the cursor **302** from the window **210** displayed on the primary display **200** to the icon **300** displayed on the secondary display **204** is denoted by the dotted line **320**. Although the line **320** is depicted as being straight, the user may have moved the cursor **302** from a location at an edge **322** of the primary display **200** to the icon **300** that does not follow the straight line **320**. The processor **102** may thus determine the location at the edge **322** of the primary display **200** at which the cursor **302** was moved out of the primary display **200** and the horizontal and vertical movements **324**, **326** of the cursor **302** from the edge **322** to the icon **300**. The processor **102** may determine the vertical position of the icon **300**, e.g., the certain display location, of the secondary display **204** with respect to the edge location **322** on the primary display **200**. In some examples, the processor **102** may determine an angle **328** at which the icon **300** is positioned from the edge location **322** with respect to a horizontal axis and may determine the vertical position of the secondary display **204** with respect to the edge location **322** from the determined angle **328**. In addition, the processor **102** may calibrate the position of the secondary display **204** with respect to the primary display **200** based on the determined vertical distance **326** and/or the determined angle **328**.

The processor **102** may execute the instructions **120** to store the determined position of the secondary display **204** with respect to the primary display **200**. Particularly, the processor **102** may determine the location of the secondary display **204** with respect to the primary display **200** based on the direction in which the cursor **302** moved and the determined vertical distance of the icon **300** with respect to the edge location **322**. The processor **102** may store the determined position (position information **216**) of the secondary display **204** with respect to the primary display **200** in the data store **106**. The position information **216** may include both the horizontal position and the vertical position of the secondary display **204** with respect to the primary display **200**. In addition, the processor **102** may use the determined position of the secondary display **204** with respect to the

primary display **200** to accurately use the secondary display **204** as an extended display of the primary display **200**.

In some examples, the processor **102** may display representations **310**, **312** of the primary display **200** and the secondary display **204** as shown in FIG. **3**E. The representation **312** of the secondary display **204** may be positioned at a location with respect to the primary display **200** that corresponds to the determined position of the secondary display **204** with respect to the primary display **200**. The processor **102** may also display an option **330** for the user to confirm that the determined position of the secondary display **204** with respect to the primary display **200** as shown in the window **210** is correct. In instances in which the user selects the option **330** to confirm that the determined position of the secondary display **204** with respect to the primary display **200** is correct, the processor **102** may store the determined position of the secondary display **204**. However, in instances in which the user does not confirm that the determined position is correct, the user may move the representation **312** of the secondary display **204** in the window **210** to another position. The user may also move the representation **312** of the secondary display **204** if, for instance, the user moves the secondary display **204** to another position with respect to the primary display **200**. In any of these instances, the processor **102** may store the position of the secondary display **204** to correspond to the position of the representation **312** of the secondary display **204** as shown in the window **210**.

In some instances, the user may set up multiple secondary displays **204**, **340** with respect to the primary display **200**. An example of the primary display **200** with multiple secondary displays **204**, **340** is shown in FIG. **3**F. Particularly, a secondary display **204** and a tertiary display **340** may be positioned adjacent to a primary display **200**. In these instances, the processor **102** may determine the locations of both the secondary display **204** and the tertiary display **340** with respect to the primary display **200**. In some examples, the processor **102** may determine the locations of both the secondary display **204** and the tertiary display **340** based on a movement of the cursor **302** from the primary display **200**, through the secondary display **204** and to an icon **342** displayed on the tertiary display **340**. That is, the processor **102** may determine the locations of both the secondary display **204** and the tertiary display **340** without causing the icon **300** to be displayed on the secondary display **204**.

In these examples, the processor **102** may cause the icon **342** to be displayed at a certain location on the tertiary display **340** and the processor **102** may track the movement of the cursor **302** from the primary display **200**, through the secondary display **204**, and to the icon **342** displayed on the tertiary display **340**. with respect to the primary display **200**. The processor **102** may also cause a video or another set of instructional images to be displayed on the primary display **200** to instruct the user to move the cursor **302** from the primary display **200** to the icon **342** displayed on the tertiary display **340**. In any regard, the processor **102** may determine the location, e.g., the horizontal direction and vertical distance, of the tertiary display **340** with respect to the primary display **200** based on the cursor **302** movement. In addition, the processor **102** may determine the horizontal direction and may infer the vertical distance of the secondary display **204** with respect to the primary display **200** and the tertiary display **340** based on the movement of the cursor **302** through the secondary display **204**.

In other examples, the processor **102** may determine the locations of the secondary display **204** and the tertiary display **340** in two separate operations. That is, the processor **102** may cause the icon **300** to be displayed on the secondary display **204** and the icon **342** to be displayed on the tertiary display **340**. In these examples, the processor **102** may track movement of the cursor **302** from the primary display **200** to the icon **300** and may determine the location of the secondary display **204** with respect to the primary display **200** based on the tracked movement. The processor **102** may also track movement of the cursor **302** from the primary display **200** (or the icon **300** displayed on the secondary display **204**) to the icon **342** displayed on the tertiary display **340**. The processor may determine the location of the tertiary display **340** with respect to the primary display **200** (and/or the secondary display **204**) from the tracked movement. The processor **102** may perform this technique to determine the locations of the secondary display **204** and the tertiary display **340** in instances in which the primary display **200** is positioned between the secondary display **204** and the tertiary display **340**.

The processor **102** may determine locations of any additional displays in similar manners to any of the manners discussed above.

Although the instructions **110-120** are described herein as being stored on the memory **104** and may thus include a set of machine-readable instructions, the apparatus **100** may include hardware logic blocks that may perform functions similar to the instructions **110-120**. For instance, the processor **102** may include hardware components that may execute the instructions **110-120**. In other examples, the apparatus **100** may include a combination of instructions and hardware logic blocks to implement or execute functions corresponding to the instructions **110-120**. In any of these examples, the processor **102** may implement the hardware logic blocks and/or execute the instructions **110-120**. As discussed herein, the apparatus **100** may include additional instructions and/or hardware logic blocks such that the processor **102** may execute operations in addition to or in place of those discussed above with respect to FIG. **1**.

Various manners in which the processor **102** of the apparatus **100** may operate are discussed in greater detail with respect to the method **400** depicted in FIG. **4**. Particularly, FIG. **4** depicts a flow diagram of a method **400** for determining a position of a secondary display **204** with respect to a primary display **200** and for using the determined position to extend a display of images between the primary display **200** and the secondary display **204**, in accordance with an embodiment of the present disclosure. It should be understood that the method **400** may include additional operations and that some of the operations described therein may be removed and/or modified without departing from the scope of the method **400**. The description of the method **400** is made with reference to the features depicted in FIGS. **1-3**F for purposes of illustration.

At block **402**, the processor **102** may determine that a secondary display **204** has been connected to an apparatus **100**. As discussed herein, the processor **102** may be a processor of the apparatus **100**. The processor **102** may also determine that the secondary display **204** has been connected to the apparatus **100** for the first time as also discussed herein.

At block **404**, the processor **102** may cause an icon **300** to be displayed at a certain display location of the secondary display **204**. As discussed herein, the processor **102** may receive information from the secondary display **204** and may determine properties of the secondary display **204** from the received information. The processor **102** may further determine the certain display location of the secondary display **204** from the determined properties of the secondary display

204, such as, a resolution of the secondary display **204**, physical dimensions of the secondary display **204**, etc.

In some examples, responsive to the determination that the secondary display **204** has been connected to the apparatus **100**, the processor **102** may cause a window **210** including an option **212** for a user to proceed with a location detection operation of the secondary display **204** to be displayed on the primary display **200**. The processor **102** may also cause the icon **300** to be displayed at the certain display location of the secondary display **204** in response to receipt of an instruction to proceed with the location detection operation of the secondary display **204**.

In some examples, the processor **102** may cause the window **210** to display an option **304**, **306** for the user to select whether the secondary display **204** is to duplicate the primary display **200** or to extend a display of the primary display **200**. The processor **102** may cause the icon **300** to be displayed at the certain display location of the secondary display **204** in response to a detection that the secondary display **204** is to extend the display of the primary display **200**. However, the processor **102** may cancel the location detection operation of the secondary display **204** in response to a detection that the secondary display **204** is to duplicate the display of the primary display **200**. In addition, the processor **102** may duplicate, e.g., mirror, the display of the primary display **200** on the secondary display **204**.

In response to a determination that the location detection operation is to proceed, the processor **102** may cause representations **310**, **312** of the primary display **200** and the secondary display **204** to be displayed on the primary display **200**. The processor **102** may also cause an animation of a representation of a cursor **316** moving from the representation **310** of the primary display **200** to a representation **314** of an icon displayed on the representation **312** of the secondary display **204** to instruct the user to move the cursor **302** displayed on the primary display **200** to the icon **300** displayed on the secondary display **204**.

At block **406**, the processor **102** may track a movement of a cursor **302** from the primary display **200** to the icon **300** displayed at the certain display location of the secondary display **204**. In some examples, the processor **102** may track a horizontal distance **324**, a vertical distance **326**, and/or an angle from where the cursor **302** moved from the primary display **200** to the secondary display **204** to the icon **300** displayed on the secondary display **204**.

At block **408**, the processor **102** may determine a position of the secondary display **204** with respect to the primary display **200** based on the tracked movement of the cursor **302**. For instance, the processor **102** may calibrate the position of the secondary display **204** with respect to the primary display **200** based on the tracked horizontal distance **324**, vertical distance **326**, and/or angle **328**.

At block **410**, the processor **102** may use the determined position of the secondary display with respect to the primary display to extend a display of images between the primary display **200** and the secondary display **204**. This may include storing of the position information **216** in the data store **106**. In some examples, the processor **102** may display representations **310**, **312** of the primary display **200** and the secondary display **204**, in which the representation **312** of the secondary display **204** is positioned at a location with respect to the representation **310** of the primary display **200** that corresponds to the determined position of the secondary display **204** with respect to the primary display **200**. In addition, the processor **102** may display an option **330** for the user to confirm that the determined position of the secondary display **204** with respect to the primary display **200** is correct.

Some or all of the operations set forth in the method **400** may be included as utilities, programs, or subprograms, in any desired computer accessible medium. In addition, the method **400** may be embodied by computer programs, which may exist in a variety of forms both active and inactive. For example, they may exist as machine-readable instructions, including source code, object code, executable code or other formats. Any of the above may be embodied on a non-transitory computer readable storage medium.

Examples of non-transitory computer readable storage media include computer system RAM, ROM, EPROM, EEPROM, and magnetic or optical disks or tapes. It is therefore to be understood that any electronic device capable of executing the above-described functions may perform those functions enumerated above.

Turning now to FIG. **5**, there is shown a block diagram of a computer-readable medium **500** that may have stored thereon computer-readable instructions for determining a position of a secondary display **204** with respect to a primary display **200** based on a tracked movement of a cursor **302** from the primary display **200** to an icon **300** displayed at a certain display location of the secondary display **204**, in accordance with an embodiment of the present disclosure. It should be understood that the computer-readable medium **500** depicted in FIG. **5** may include additional instructions and that some of the instructions described herein may be removed and/or modified without departing from the scope of the computer-readable medium **500** disclosed herein. The computer-readable medium **500** may be a non-transitory computer-readable medium, in which the term "non-transitory" does not encompass transitory propagating signals.

The computer-readable medium **500** may have stored thereon computer-readable instructions **502-512** that a processor, such as the processor **102** of the apparatus **100** depicted in FIGS. **1** and **2**, may execute. The computer-readable medium **500** may be an electronic, magnetic, optical, or other physical storage device that contains or stores executable instructions. The computer-readable medium **500** may be, for example, Random Access memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage device, an optical disc, and the like.

The processor may fetch, decode, and execute the instructions **502** to determine that the processor has access to a newly discovered secondary display **204**. The processor may fetch, decode, and execute the instructions **504** to cause a window **210** including an option **212** to proceed with a location detection operation of the secondary display **204** to be displayed on a primary display **200**. The processor may fetch, decode, and execute the instructions **506** to cause an icon **300** to be displayed at a certain display location of the secondary display **204** in response to a determination that the location detection operation of the secondary display **204** is to continue, the processor may cause the window **210** to display an option **304**, **306** for a selection of whether the secondary display **204** is to duplicate the primary display **200** or to extend a display of the primary display **200**. In addition, the processor may cause the icon **300** to be displayed at the certain display location of the secondary display **204** in response to a detection that the secondary display **204** is to extend the display of the primary display **200**. Alternatively, the processor may cancel the location detection operation of the secondary display **204** in response

to a detection that the secondary display **204** or another display (not shown) is to duplicate, e.g., mirror, the primary display **200**.

In some examples, in response to a determination that the location detection operation is to proceed, the processor may cause representations **310**, **312** of the primary display **200** and the secondary display **204** to be displayed on the primary display **200**. The processor may also cause an animation of a cursor **316** moving from the representation **310** of the primary display **200** to a representation **314** of an icon displayed on the representation **312** of the secondary display **204** to instruct the user to move the cursor **302** displayed on the primary display **200** to the icon **300** displayed on the secondary display **204**.

The processor may fetch, decode, and execute the instructions **508** to track a movement of a cursor **302** from the primary display **200** to the icon **300** displayed at the certain display location of the secondary display **204**. For instance, the processor may track both a vertical distance **326** and a horizontal distance **324** from where the cursor **302** moved from the primary display **200** to the secondary display **204** to the icon **300** displayed on the secondary display **204**. The processor may also calibrate the position of the secondary display **204** with respect to the primary display **200** based on the tracked movement.

The processor may fetch, decode, and execute the instructions **510** to determine a position of the secondary display **204** with respect to the primary display **200** based on the tracked movement of the cursor **302**. The processor may fetch, decode, and execute the instructions **512** to use the determined position of the secondary display **204** with respect to the primary display **200** to extend a display of images between the primary display **200** and the secondary display **204**.

In some examples, the processor may provide a user interface that may present a post-configuration to the user in which the user is able to fine tune or augment the configuration of the displays **200**, **204**. The user interface may show how the displays **200**, **204** intersect each other at their edges and other potential post configuration signals. The user interface may, for instance, display representations of the displays **200**, **204** that correspond to the logical sizes, e.g., pixels, of the displays **200**, **204**. By way of example, the processor may cause a tall and thin rectangle to graphically represent a logically larger secondary display **204** and allowing the user to move that rectangle vertically to fine tune the vertical alignment of the secondary display **204** in a way that conveys the logical vs physical nature of the relationship between the primary display **200** and the secondary display **204**.

Although described specifically throughout the entirety of the instant disclosure, representative examples of the present disclosure have utility over a wide range of applications, and the above discussion is not intended and should not be construed to be limiting, but is offered as an illustrative discussion of aspects of the disclosure.

What has been described and illustrated herein is an example of the disclosure along with some of its variations. The terms, descriptions and figures used herein are set forth by way of illustration only and are not meant as limitations. Many variations are possible within the scope of the disclosure, which is intended to be defined by the following claims—and their equivalents—in which all terms are meant in their broadest reasonable sense unless otherwise indicated.

What is claimed is:

1. An apparatus comprising:

a processor; and

a memory on which is stored machine-readable instructions that when executed by the processor, cause the processor to:

responsive to a determination that a secondary display has been connected to the apparatus, cause a window including an option for a user to proceed with a location detection operation of the secondary display to be displayed on a primary display;

cause an icon to be displayed at a certain display location of the secondary display in response to receipt of an instruction to proceed with the location detection operation of the secondary display;

track a movement of a cursor from the primary display to the icon displayed on the secondary display;

determine a position of the secondary display with respect to the primary display based on the tracked movement of the cursor; and

store the determined position of the secondary display with respect to the primary display.

2. The apparatus of claim **1**, wherein the instructions cause the processor to:

determine that the secondary display is connected to the apparatus for a first time; and

in response to the determination that the secondary display is connected to the apparatus for a first time, cause the window including the option for the user to proceed with the location detection operation to be displayed on the primary display.

3. The apparatus of claim **1**, wherein the instructions cause the processor to:

receive information from the secondary display; and

determine properties of the secondary display from the received information;

determine a certain display location of the secondary display from the determined properties of the secondary display; and

cause the icon to be displayed at the certain display location of the secondary display.

4. The apparatus of claim **1**, wherein the instructions cause the processor to:

cause the window to display an option for the user to select whether the secondary display is to duplicate the primary display or to extend a display of the primary display; and

cause the icon to be displayed on the secondary display in response to a detection that the secondary display is to extend the display of the primary display.

5. The apparatus of claim **4**, wherein the instructions cause the processor to:

cancel the location detection operation of the secondary display in response to a detection that the secondary display is to duplicate the display on the primary display.

6. The apparatus of claim **1**, wherein the instructions cause the processor to:

in response to a determination that the location detection operation is to proceed, cause representations of the primary display and the secondary display to be displayed on the primary display; and

cause an animation of a cursor moving from the representation of the primary display to an icon displayed on the representation of the secondary display to instruct the user to move the cursor displayed on the primary display to the icon displayed on the secondary display.

7. The apparatus of claim 1, wherein the instructions cause the processor to:

display representations of the primary display and the secondary display, wherein the representation of the secondary display is positioned at a location with respect to the representation of the primary display that corresponds to the determined position of the secondary display with respect to the primary display; and

display an option for the user to confirm that the determined position of the secondary display with respect to the primary display is correct.

8. The apparatus of claim 1, wherein the instructions cause the processor to:

determine an angle at which the cursor moved from the primary display to the icon displayed on the secondary display; and

calibrate the position of the secondary display with respect to the primary display based on the determined angle.

9. The apparatus of claim 1, wherein the instructions cause the processor to:

cause an icon to be displayed on a tertiary display;

track a movement of a cursor from at least one of the primary display and the secondary display to the icon displayed on the tertiary display;

determine a position of the tertiary display with respect to the primary display and the secondary display based on the tracked movement of the cursor from at least one of the primary display and the secondary display to the icon displayed on the tertiary display; and

store the determined position of the tertiary display with respect to the primary display and the secondary display.

10. A method comprising:

determining, by a processor, that a secondary display has been connected to an apparatus;

responsive to the determination that the secondary display has been connected to the apparatus, causing, by the processor, a window including an option for a user to proceed with a location detection operation of the secondary display to be displayed on the primary display;

causing, by the processor, an icon to be displayed at a certain display location of the secondary display in response to receipt of an instruction to proceed with the location detection operation of the secondary display;

tracking, by the processor, a movement of a cursor from a primary display to the icon displayed at the certain display location of the secondary display;

determining, by the processor, a position of the secondary display with respect to the primary display based on the tracked movement of the cursor; and

using, by the processor, the determined position of the secondary display with respect to the primary display to extend a display of images between the primary display and the secondary display.

11. The method of claim 10, further comprising:

causing the window to display an option for the user to select whether the secondary display is to duplicate the primary display or to extend a display of the primary display;

causing the icon to be displayed at the certain display location of the secondary display in response to a detection that the secondary display is to extend the display of the primary display; or

canceling the location detection operation of the secondary display in response to a detection that the secondary display is to duplicate the display of the primary display.

12. The method of claim 10, further comprising:

in response to a determination that the location detection operation is to proceed, causing representations of the primary display and the secondary display to be displayed on the primary display; and

causing an animation of a cursor moving from the representation of the primary display to an icon displayed on the representation of the secondary display to instruct the user to move the cursor displayed on the primary display to the icon displayed on the secondary display.

13. The method of claim 10, further comprising:

receiving information from the secondary display;

determining properties of the secondary display from the received information; and

determining the certain display location of the secondary display from the determined properties of the secondary display.

14. The method of claim 10, further comprising:

displaying representations of the primary display and the secondary display, wherein the representation of the secondary display is positioned at a location with respect to the representation of the primary display that corresponds to the determined position of the secondary display with respect to the primary display; and

displaying an option for a user to confirm that the determined position of the secondary display with respect to the primary display is correct.

15. The method of claim 10, further comprising:

determining an angle at which the cursor moved from the primary display to the icon displayed on the secondary display; and

calibrating the position of the secondary display with respect to the primary display based on the determined angle.

16. A computer-readable medium on which is stored computer-readable instructions that when executed by a processor, cause the processor to:

determine that the processor has access to a newly discovered secondary display;

responsive to a determination that the secondary display has been newly discovered, cause a window including an option to proceed with a location detection operation of the secondary display to be displayed on a primary display;

cause an icon to be displayed at a certain display location of the secondary display in response to receipt of an instruction to proceed with the location detection operation of the secondary display;

track a movement of a cursor from the primary display to the icon displayed at the certain display location of the secondary display;

determine a position of the secondary display with respect to the primary display based on the tracked movement of the cursor; and

use the determined position of the secondary display with respect to the primary display to extend a display of images between the primary display and the secondary display.

17. The computer-readable medium of claim 16, wherein the instructions further cause the processor to:

cause the window to display an option for a selection of whether the secondary display is to duplicate the primary display or to extend a display of the primary display;

cause the icon to be displayed at the certain display location of the secondary display in response to a detection that the secondary display is to extend the display of the primary display; or

cancel the location detection operation of the secondary display in response to a detection that the secondary display is to duplicate the primary display.

18. The computer-readable medium of claim **17**, wherein the instructions further cause the processor to:

in response to a determination that the location detection operation is to proceed, cause representations of the primary display and the secondary display to be displayed on the primary display; and

cause an animation of a cursor moving from the representation of the primary display to an icon displayed on the representation of the secondary display to instruct a user to move the cursor displayed on the primary display to the icon displayed on the secondary display.

19. The computer-readable medium of claim **16**, wherein the instructions further cause the processor to:

determine an angle at which the cursor moved from the primary display to the icon displayed on the secondary display; and

calibrate the position of the secondary display with respect to the primary display based on the determined angle.

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